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Materiel Test Procedure 6-3-027
U. S. Army Aviation Test BoardU. S. ARMY TEST AND EVALUATION COMMAND
COMMODITY SERVICE TEST PROCEDURE

ACOUSTICAL (GUN) FIRE DETECTION SYSTEMS

1. OBJECTIVE

This document provides existing test methods and techniques necessary to determine the degree to which aircraft acoustical fire detection systems and their associated tools and test equipment (maintenance package) meet the requirements stated in Qualitative Materiel Requirements (QMR's), Small Development Requirements (SDR's), or Technical Characteristics (TC's), and whether or not the system is suitable for Army use.

2. BACKGROUND

Acoustical fire detection systems are utilized on Army aircraft to alert crew members to the presence of weapons fire where they would otherwise not be aware of such fire due to the acoustic mask provided by the aircraft enclosure and/or normal environmental noise.

These systems will include in their design, some type of aircraft surface mounted transducer which converts sound waves to electrical signals and a receiver for processing the electrical signals. The signals may also be filtered where it is desired to selectively monitor acoustic signals within particular frequency ranges. This is an extremely desirable characteristic where such filtering will aid in the elimination of undesirable signals resulting from environmental noise, thereby eliminating "false warnings."

These systems have basically only a single function: to warn air crewmen of weapons fire. This function should preferably be achieved regardless of the position of the firing weapon with respect to aircraft heading (constancy of detection pattern) and of distance to the firing weapon (up to the maximum range). Maximum achievement on these two parameters, while maintaining reduced susceptibility to environmental noise, will define the system's effectiveness. Operational tests of the system will emphasize the evaluation of these important characteristics. Reliability of the system is also extremely important and must be maintained in the various environments (mechanical, atmospheric changes, electromagnetic) to which the system is exposed while the aircraft is engaged in the normal flight procedures utilized in training and mission operations. Other factors, such as flexible installation and physical characteristics rendering the system for use in different aircraft, will also be examined. The total testing program shall verify the suitability of the system for use by the Army.

3. REQUIRED SUPPORT3.1 FACILITIES

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- a. Appropriate number and type of test bed aircraft.
- b. Various weapons systems, small arms, ammunition, etc.

3.3 PERSONNEL

Personnel in appropriate numbers, of the proper MOS, grade, skill level, and with special training as required.

4. REFERENCES

- A. AR 385-16, Safety for Systems, Associated Subsystems, and Equipment.
- B. USAMC Regulation No. 385-12, Verification of Material from Material Development through Testing, Production and Supply to Disposition.
- C. USAMC Supplement 1 to AR 385-16, Safety: Safety for Systems, Associated Subsystems, and Equipment.
- D. USATECOM Regulation No. 70-23, Research and Development: Equipment Performance Reports (EPR's).
- E. USATECOM Regulation No. 70-24, Research and Development: Documenting Test Plans and Reports.
- F. USATECOM Regulation No. 108-1, Photographic Coverage (as implemented by USAAVNTBD Memorandum No. 108-1).
- G. USATECOM Regulation No. 385-6, Safety: Verification of Safety of Materiel During Testing (as implemented by USAAVNTBD Memorandum No. 385-10).
- H. USATECOM Regulation No. 750-15, Maintenance Evaluation during Testing (as implemented by USAAVNTBD Memorandum No. 750-2).
- I. Military Standard 882, System Safety Program for Systems and Associated Subsystems and Equipment; Requirements for.
- J. Military Standard 454B, Standard General Requirements for Electronic Equipment.
- K. MTP 6-3-501, Pre-Test Inspection for Service Test.
- L. MTP 6-3-502, Personnel Training Requirements.
- M. MTP 6-3-513, Qualitative Electromagnetic Interference.
- N. MTP 7-3-500, Physical Characteristics.
- O. MTP 7-3-502, Installation Characteristics.
- P. MTP 7-3-506, Safety.
- Q. MTP 7-3-507, Maintenance.
- R. MTP 7-3-508, Reliability.
- S. MTP 7-3-509, Compatibility with Related Equipment.
- T. MTP 7-3-510, Human Factors.
- U. QMR, SDR, or TC's for the detection system.

5. SCOPE

5.1 SUMMARY

This document provides existing procedures for evaluating the

characteristics of acoustical detection systems installed on Army aircraft. The procedures comprising the total testing program are summarized in the following paragraphs.

5.1.1 Preparation for Test

This section provides guidance for test project planning including procedures for the training of test personnel.

5.1.2 Test Conduct

The procedures to be utilized in conducting the individual test are given in this section. The following tests will be conducted on aircraft acoustical detection systems.

a. Inspection - A series of preliminary tests to determine that the system is in satisfactory condition prior to the operational test. The following will be included:

- 1) Inventory check and visual inspection.
- 2) Determination of physical characteristics.
- 3) Technical characteristics.

b. Installation - An evaluation of the installation characteristics including replacement and removal procedures, stability of mounting, and flexibility for use on various aircraft.

c. Operation and Performance - A determination of the operation and performance characteristics of the system under conditions that most nearly simulate those expected to be encountered in the field.

d. Maintenance - An evaluation of the equipment's maintenance characteristics and the maintenance package through examination of maintainability, reliability, and availability. The purpose of this evaluation is to determine through examination of the design, maintenance procedures, tools, literature, etc., the ease with which the system can be maintained at or be returned to operative condition. Analysis of failures is also included.

e. Compatibility - An evaluation of the effects and interactions of the detection system with the established configuration of the aircraft and its mission profiles. This is a measure of the degree to which requirements for the system differ from, require special considerations for, or interfere with tactical procedures, equipment, tools, and materials.

f. Draft Technical Manuals - An examination of the contents of draft technical literature to determine accuracy, completeness, prescribed format, and clarity.

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g. Safety - An evaluation which examines the safety characteristics of the design and operating procedures of the system, the objective of which is to minimize personnel injury, materiel failures, malfunctions, and equipment losses.

h. Human Factors - An evaluation to determine the adequacy of the design and performance characteristics in terms of compatibility with specified user personnel in the operational environment. Characteristics as related to human factors and revealed during the conduct of each test shall be examined.

i. Personnel and Training Requirements - An evaluation which, through observation of personnel involved in operation and maintenance procedures, will be utilized to determine the adequacy and sufficiency of training and appropriateness of skill levels and experience specified for the selected test personnel.

5.1.3 Test Data

This section details the data to be collected and recorded while completing the test procedures in paragraph 6.2, Test Conduct.

5.1.4 Data Reduction and Presentation

This section provides instructions for evaluating and displaying the data recorded during testing.

5.2 LIMITATIONS

This MTP is intended to be used as a basic guide in preparing test plans for the subject equipment. The procedures specified apply to the service test evaluation of aircraft systems which detect ground weapon fire utilizing an acoustical detection system and provide warning to aircraft crewmen. Pertinent WMR, SDR, TC's and other applicable documents will be utilized to derive test criteria and to formulate test conditions.

6. PROCEDURES

6.1 PREPARATION FOR TEST

6.1.1 Test Planning

6.1.1.1 General

Utilize reference 4E to formulate the plan of test. Certain general procedures to be followed in the generation of a test plan are contained in the following:

- a. Review the test directive to determine test objectives.

b. Determine criteria for the tests by reviewing QMR's, SDR's, and TC's for the system to be tested and other applicable sources containing test criteria germane to the system.

c. Become familiar with the system's technical and operational characteristics.

d. Prepare a detailed test schedule showing proposed time periods allotted for each test listed in section 5.1.2. Where possible, allow sufficient time to evaluate durability and reliability characteristics.

e. Plan to use photographic techniques where possible to record and document findings and results of testing. Reference 4F shall be consulted for procedures.

6.1.1.2 Support

Review the support requirements of section 3. and any additional support determined while ascertaining test criteria. Analyze these requirements with respect to availability and scheduling.

6.1.1.3 Personnel

a. Select test personnel of the proper MOS with varying skill levels and backgrounds to determine the optimum user and maintenance personnel.

b. Train test personnel to operate and maintain the equipment using the draft literature.

c. Determine qualification in accordance with the requirements of MTP 6-3-502; in particular ensure that test personnel are aware of test objectives and knowledgeable in the procedures to be utilized.

6.2 TEST CONDUCT

6.2.1 Inspection

6.2.1.1 Inventory Check and Visual Inspection

Perform the following:

a. An inventory check against the Basic Issue Item List (BIIL), submitting an Equipment Performance Report (EPR) for each noted shortage or discrepancy in accordance with the provisions of USATECOM Regulation 70-23.

b. Pretest inspection procedures required by MTP 6-3-501; in particular:

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- 1) Visually inspect for defects.
- 2) Remove all preservatives.
- 3) Verify lubrication required.
- 4) Check for completeness of assembly.

6.2.1.2 Physical Characteristics

NOTE: Do not test for data obtained and verified during the Engineering Test.

Physical characteristics shall be determined by performing the applicable sections of MTP 7-3-500, in particular the following:

- a. Markings - Note the legibility and effectiveness of markings, legends, etc.
- b. Dimension and weight data - Determine the dimensions, weight, and volume of all assembly components.
- c. Compute the system's total weight and volume.

6.2.1.3 Technical Characteristics

Examine the following technical properties utilizing a bench test set-up if required.

- a. Power Requirements - Examine power input circuit for correctness and measure the electrical power requirements of the system. Ensure that all requirements are satisfied by the electrical systems available on the types of aircraft on which the test item will be utilized and that equipment power requirements do not exceed the allowable limits.
- b. Controls, adjustments, and indicators (mechanical and electrical).

- 1) For each control, adjustment, and indicator determine the following as appropriate:
 - a) Operation is correct.
 - b) Effect on the system is as required.
 - c) Absence of binding and rubbing.
 - d) Calibration is proper.
 - e) Changes are monitored and displayed correctly.
 - f) Range and sensitivity is correct.
 - g) Control and/or indicator position permits positive crew response and reaction.
- 2) List any discrepancies.

NOTE: Devices whose evaluation require flight conditions will be checked during the Operation and Performance Test.

- c. Equipment safety and protective devices - Determine adequacy of each.
- d. Fail-Safe Characteristics - Examine the system for the following:
 - 1) Internal failure - When the system becomes inoperative because of an internal failure, operators shall be made aware of the condition. Simulate failures and verify indication.
 - 2) Acceptance or provision of external signals - If the system accepts/provides electrical signals from/to other on-board avionics equipment, operators shall be made aware of any out of limit level existing on any line. Simulate failures on each line and check for indication.
- e. Confidence, self checking or integrity circuits - If any, verify proper operation.
- f. Primary technical characteristics - Measure sensor sensitivity and frequency selectivity.
- g. Cold start and warm-up - Subject the system to a minimum of three consecutive cold start power application procedures. Determine warm-up time and effects due to multiple power applications.

6.2.2 Installation

Evaluate the installation properties of the system utilizing the requirements of MTP 7-3-502, including the following:

- a. Determine the requirements (time, effort, tools, materials, personnel, instructions, etc.) for installing and removing the system. Record recommendations for the elimination of, minimization, or improvements to any of these requirements.
- b. Examine the installed system to ensure that it is secure, protected against shock and vibration, and, in general, mechanically stable.
- c. Examine the system and its mounting requirements for use on various types of aircraft. Determine for which aircraft extensive modifications are required or those which will not accept the acoustical detection system.

6.2.3 Operation and Performance

The system shall be tested for its ability to alert personnel within the aircraft to the presence of weapons fire directed at or near the aircraft. The subtests presented are arranged for a sequential approach to

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this determination by: examining the performance of the system in the various environmental noise configurations in which it will be found, subjecting the system to the presence of weapons fire (using the information gained during the environmental noise tests), and determining the detection pattern and its variation with such variables as airspeed, weapon type, firing mode, etc. A simulated tactical mission will culminate the tests. Emphasis during all tests will be to determine the maximum capability of the system independent of the environmental noise conditions.

6.2.3.1 Environmental Noise Tests

Perform the following:

a. Examine the response of the system to the various environmental noise conditions encountered during normal training and field operation.

b. Determine for each of the situations listed below, the settings required on the equipment to eliminate or, if that is not possible, to minimize the occurrence of false indications. Prepare the data in tabular form as in the example below. The achieved level of nullification of false counts shall be expressed as either 100 percent or as the number of false counts per unit of time.

CONTROL				NOISE ENVIRONMENT	LEVEL OF FALSE COUNTS
	GAIN OR SENSITIVITY	FREQUENCY OR FILTER	PULSE WIDTH		
SETTING	4.6/10.0	5kc	2.0 MICRO- SECONDS	SEE BELOW	100% OR 5 COUNTS/ SECOND

c. Perform a noise evaluation for each of the following situations:

- 1) Equipped aircraft on ground and isolated from all other noise sources. Cycle aircraft engine and other onboard noise generating devices through their full operating range.
- 2) Equipped aircraft on ground with its engine inoperative and in proximity to noise generating equipment; e.g., other types of aircraft, vehicles, and APU's.
- 3) Aircraft in solo flight over various terrain types.
- 4) Repeat step 3. except fire all onboard weapon systems, if applicable.

- 5) Aircraft in flight, in proximity to other types of aircraft firing weapons systems.

6.2.3.2 Fire Detection Tests - Aircraft on Ground

Determine the system's characteristics while the aircraft is on the ground and exposed to weapons fire. This test is intended to create the conditions which may exist when the aircraft is conducting a ground level operation in a hostile environment. Perform the following:

- a. Place equipment settings to those values determined in procedure 6.2.3.1, situation c.1).
- b. Situate the aircraft in a typical landing position; i.e., a relatively flat area with moderate vegetation.
- c. Have weapon projectiles pass at a minimum safe distance to aircraft. Include the following variations during the tests.
 - 1) Use different types of weapons.
 - 2) Use different types of ammunition.
 - 3) Direct the fire in at least four different directions preferably the four cardinal directions with respect to the aircraft longitudinal axis.
 - 4) Use different types of weapons fire; e.g., automatic, semiautomatic.
 - 5) Vary the firing distance from the aircraft for each direction, starting at one hundred feet and progressing outward.
- d. Maintain radio communication with personnel in the aircraft for coordination of all firing procedures. Have crewman report the number of counts and indicated the firing mode; e.g., automatic, etc., where applicable. The reports may be recorded by aircrewmembers or by test personnel present at the firing locations.

6.2.3.3. Fire Detection Tests - Aircraft Airborne

With the aircraft airborne, determine the detection pattern in internal and vertical planes and also the spherical pattern. Perform the following:

- a. Establish a ground-level position or location from which weapons will be fired.
- b. Conduct the following flight procedures with respect to the firing position.

- 1) Rotary-wing aircraft - Conduct one test with the aircraft hovering and oriented successively in the four major directions with respect to the firing position.
- 2) Rotary and fixed-wing - Conduct one test during which the aircraft will be flown towards, away from, from left to right in front of, and from right to left in front of the firing position.

c. Flight and hover altitudes and the distance of the firing location from the aircraft will be determined by examining such factors as miss distance, safety, aircraft capabilities, weapons utilized, degree of control available, etc.

d. For each of the four profiles which can be assumed by the aircraft, as in section b., conduct firing tests on the system. The firing pattern shall consist of a semicircular design, with the aircraft at the center and the radius being denoted as the "miss distance." No projectiles will be fired so as to be above or in front of the aircraft during side-to-side flight procedures. Include the following in the conduct of the firing tests:

- 1) Utilize both semiautomatic and automatic fire from various types of weapons and with different types of ammunition.
- 2) Fire at evenly spaced points around the semicircular pattern.
- 3) Conduct successive tests at different "miss" distances starting at the minimum safe value and increasing the distance until some value is reached where the system appears to be ineffective.

NOTE: Airmen will be informed as to when the firings will occur and will record the number of detections for each firing.

6.2.3.4 Simulated Tactical Mission

The performance of the system during a tactical operation shall be determined by the following:

- a. Establish a flight range which allows for concealment of ground personnel.
- b. Establish a flight plan which calls for a predetermined two way aerial passage over the range to a target point. Utilize an altitude commensurate with the results of testing in section 6.2.3.3.
- c. Station personnel equipped with small arms at points along the range over which the aircraft will pass.

d. Establish a communications network between all ground personnel, the aircraft, and a ground control station with ground personnel and the aircraft being "secure" to each other.

e. Have the aircraft fly the test range and attempt to detect ground fire on a spontaneous basis. Reports will be made to the control station of the detections, e.g., location, type of fire, etc.

6.2.3.5 Effects of Atmospheric Conditions

Selected environmental noise and firing tests shall be performed during periods when changes in atmospheric conditions exist to determine their effects on system performance. Safety considerations shall govern the choice of procedures. Include where possible the following:

- a. Night hours.
- b. Hours at sunrise and sunset.
- c. Poor weather conditions, poor visibility (rain, fog).
- d. High and low temperatures.

6.2.3.6 Durability

On completion of the operation and performance tests, the durability characteristics of the system will be examined. Perform the following:

- a. A visual inspection with consideration given to the following:
 - 1) Loose components, panels, hazardous connectors, or cables.
 - 2) Missing hardware.
 - 3) Broken fasteners or seams.
 - 4) Discoloration due to heat effects, rust, or corrosion.

For each defect, the nature and location shall be noted.

b. A remeasurement of primary technical characteristics to determine any degradation.

c. An examination of equipment failures isolating those that are attributed to lack of durability.

6.2.4 Maintenance

a. This test is to evaluate the maintenance characteristics of the system and to determine the adequacy of the maintenance package (tools, test equipment, etc.). The procedures of MTP 7-3-507 and reference 4F will be utilized with the total evaluation emphasizing the following:

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- 1) Maintainability.
- 2) Reliability.
- 3) Tools and test equipment.
- 4) Technical manuscripts and draft manuals.

b. Include in the maintenance subtest the preparation of the following charts:

- 1) Maintenance and Reliability Analysis Chart.
- 2) Parts Analysis Chart.
- 3) Special Tool Analysis Chart.
- 4) Maintenance Package Literature Chart.

6.2.4.1 Maintainability

a. List and provide complete details of occurrences for scheduled maintenance without downtime and unscheduled maintenance with minimum downtime (minor adjustments).

b. List and provide complete details of occurrences for unscheduled maintenance involving downtime and/or replacement or repair of components.

6.2.4.2 Reliability

Reliability will be determined during the service test by performing the following:

a. Maintain an accurate log of the accumulated run-time hours.

b. Record the following for each unscheduled maintenance involving any loss of operating time.

- 1) Conditions which indicated the malfunction.
- 2) Component of feature involved and method used to determine it.
- 3) Damage caused to associated parts of the system by failure.
- 4) Repair procedures followed and personnel, material, and tools required for repair.
- 5) Elapsed time since last malfunction, if any, or total accumulated run-time of failing component, and time to repair failure.

c. Calculate, from the times recorded, the mean time between failures (MTBF) and mean time to repair (MTTR) (see Appendix A).

d. Compute the availability figures (see Appendix A).

6.2.4.3 Tools and Test Equipment

Determine, through utilization, whether common and special tools and test equipment are suitable for the intended purpose and maintenance level and, also, whether special tools and equipment provided are excessive.

6.2.4.4 Technical Manuscripts and Draft Manuals

Perform the following:

- a. Review the maintenance instructions for preventive and major maintenance procedures for accuracy and completeness.
- b. Note the presence of lists of recommended repair parts, tools, test equipment, and procedures for alignment, calibration, and troubleshooting.

6.2.5 Compatibility

During testing, consideration should be given to compatibility of the equipment with the operating environment. Problems such as operational interference with adjacent electronic systems shall be determined.

Perform the following:

- a. Review during all procedures the problem of compatibility.
- b. Note any instances of incompatibility using the following list as a guide.
 - 1) Preparation for Use - Note the need during installation for special tools, hardware, mounting brackets, etc. and nonstandard size or overweight items.
 - 2) Operation and Performance - Note during the operational procedures whether or not the detection system interferes with or is itself interfered with by other onboard or ground based electronic systems. This can be accomplished by operating the system simultaneously with other onboard electrical systems and in the presence of radio frequency fields generated by ground installations. Compatibility of the system with other onboard electronic systems utilizing signals from or providing signals to the test system will be determined. The requirements of MTP 6-3-513, Qualitative Electromagnetic Interference, will also be satisfied.

6.2.6 Draft Technical Manuals

Technical manuals furnished shall provide procedures for operation and maintenance which are complete, accurate, understandable, and in the prescribed format.

Perform the following for each procedure conducted:

- a. Review the applicable section of the manual(s).
- b. Record any instances of literature requiring correcting, using the following examples as a general guide.
 - 1) Preparation for Use - Inadequate installation or check-out procedures.
 - 2) Operation and Performance - Instructions not sufficient to achieve proper operation.
 - 3) Transportability - Recommendations for the handling and packaging of materials, or precautions not given.
 - 4) Safety - Any required precautions not specified in the test.

6.2.7 Safety

This test is to evaluate the safety characteristics and features of the system. The requirements of MTP 7-3-506 and reference 4E shall apply.

Perform the procedures required by MTP 7-3-506 and:

- a. Observe the proper safety precautions and adhere closely to the draft manual's directives which deal with safety and/or protection.
- b. Examine the procedures for a-1 tests. Report any hazardous condition to the project officer.
- c. Examine the safety characteristics of the acoustical detection system including the procedures for its operation and maintenance to ensure that maximum safety has been provided. Consider the following:
 - 1) Examine operating procedures with a view that improperly executed or misinterpreted instructions could result in bodily harm or equipment damage.
 - 2) Where hazardous conditions cannot be avoided, is the item properly and conspicuously marked for the condition?
 - 3) Are all moving parts shielded and completely enclosed?
 - 4) Where electrical power is utilized, are the requirements of Requirement 1, MIL-STD-454B complied with?
 - 5) Are any environmental limitations explicitly denoted?
- d. Determine the adequacy of all protective and warning devices. Consider the following:
 - 1) Overheat devices.
 - 2) Overload protection.
 - 3) Locking mechanisms.

- 4) Limit switches.
- 5) Visual and audible warning devices.
- 6) Interlocks.

6.2.8 Human Factors Evaluation

a. This evaluation is designed to determine the degree to which the design and performance satisfy accepted standards of human factors. Applicable document is MTP 7-3-510. The evaluation will be conducted by preparing a human factors task and characteristics analysis checklist. The purpose of the checklist is to rate, from a human factors standpoint, the tasks associated with the characteristics revealed during the procedures for preparing, operating, transporting, and maintaining the system. The rating will be either satisfactory or unsatisfactory with explanatory information accompanying an unsatisfactory rating. The ratings may be made simultaneously with the above listed evaluation or separately. For all tasks/characteristics the following will be considered:

- 1) Ease of performance - Mental and physical effort required.
- 2) Support - Adequacy of instructions and tools for the task.
- 3) Time required - Modification of procedures to reduce time required.
- 4) Design characteristics - Effects on performance of tasks.

b. Perform the procedures required by MTP 7-3-510 and the following tasks/characteristics for the evaluation listed:

- 1) Preparation for Usage.
 - a) Assemble and install.
 1. Assemble components, move to installation location, place in position, make external connections, and lock into.
 2. Apply power and check the controls and indicators. Make required alignment, calibrate, and adjust.
 - b) Note operational status.
- 2) Operation and Performance.
 - a) Controls and indicators - Operate controls, note changes in equipment status, monitor other displays.
 - b) Legends - Effectiveness, readability, and visibility.
 - c) Performance - Note correct operation and system status feedback to operator (auditory, visual, etc.).
- 3) Maintenance
 - a) Perform preventive maintenance.
 1. Clean and add lubricants.
 2. Remove and replace minor items.
 3. Tighten fasteners and connectors.
 4. Adjust, calibrate, and align.
 - b) Perform nonscheduled maintenance.

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1. Detect malfunction by observing displays, noting visual or audible changes or changes in operating effectiveness.
 2. Isolate and identify causes by visual means of instrumentation.
- c) Remove and replace.
 1. Open, gain access to, and remove component.
 2. Replace or repair and re-establish proper operation.

6.2.9 Personnel and Training Requirements

Perform the following:

- a. Utilize personnel of varying skill levels and experience throughout the test program to determine the optimum personnel type.
- b. Review the performance of personnel during the operational and maintenance procedures paying particular attention to mistakes or errors made in operational procedures and excessively long maintenance tasks.
- c. Review the effects of the training programs as to their adequacy, etc., noting also any additional training required during the test and suggestions for changes to the training program.
- d. Make a quantitative estimate as to the average number of training hours required for both operational and maintenance personnel.

6.3 TEST DATA

6.3.1 Preparation for Test

6.3.2 Test Conduct

6.3.2.1 Inspection

6.3.2.1.1 Visual Inspection and Inventory Check

Record the following:

- a. The data required by MTP 6-3-501.
- b. Locations and types of physical defects found.
- c. Any materials missing from the Basic Issue Item List.

6.3.2.1.2 Physical Characteristics

Record the data required by MTP 7-3-500 and the following:

a. Equipment markings which are illegible or unclear.

b. Dimension, volume, and weight data for all components and total system weight and volume.

6.3.2.1.3 Technical Characteristics

Record the following:

a. Any instances of electrical incompatibility with respect to power requirements.

b. For all controls and indicators, list beside each item any of the following conditions:

- 1) Improper operation.
- 2) Desired effect on system not indicated.
- 3) Binding, rubbing or jerky in motion.
- 4) Improper calibration.
- 5) Proper monitoring and display of system conditions not shown.
- 6) Range too small, too large, etc.

c. Any protective or safety device which does not operate properly.

d. Any evidence that the system does not meet fail-safe requirements, e.g., internal failure is not indicated.

e. Any problems encountered in the operation of self-checking or integrity circuits.

f. Any technical characteristic which fails to meet required specifications.

g. Evidence of excessive warm-up time or improper operation following power application procedures.

6.3.2.2 Installation

Record the following:

a. The data required by MTP 7-3-502.

b. All data associated with the installation or removal of the system, on each type aircraft, and any recommendations for improvement to these requirements.

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c. Any evidence that the installed system is not mechanically stable, e.g., insufficient fasteners, cables not protected, etc.

d. List each aircraft on which the system cannot be installed or to which extensive modifications are required.

6.3.2.3 Operation and Performance

6.3.2.3.1 Environmental Noise Tests

Perform the following:

a. Prepare tables to be used in recording data. Include in the form all variables provided on the system which can be used to control its response.

b. For the various noise environments tested, provide complete details concerning conditions existing and, in particular, record conditions existing when the majority of miscounts occurred.

c. Record comments concerning the effectiveness of controls, stability of the system, etc.

6.3.2.3.2 Fire Detection Tests - Aircraft on Ground

Perform the following:

a. Record all equipment settings.

b. Describe the geographical condition of the test site.

c. For each test conducted, record the following:

1) Direction and distance of firing point.

2) Weapon and ammunition types.

3) Firing modes used.

4) Number of detections made versus the number of firings.

6.3.2.3.3 Fire Detection Tests - Aircraft Airborne

Perform the following:

a. Record a detailed description of the test range.

b. List each aircraft utilized in the testing.

c. Record the aircraft profile for each test including the following:

- 1) Altitude, distance from firing point.
- 2) For both hovering and moving procedures the direction of the aircraft longitudinal axis with respect to the firing location - towards, away, left to right, or right to left.

d. Record the weapon type, ammunition, and firing mode.

e. Arrange the remaining test data in tabular form listing miss distance, angle with respect to plane altitude, direction of aircraft axis, and counts detected versus firings. As an example use the following:

Miss Distance				Direction of Aircraft Axis
Angle	100'	150'	200'	Towards, away, etc.
0°	2/4	1/4	0/4	
30°	4/4	3/4	2/4	
60°	4/4	2/4	0/4	

6.3.2.3.4 Simulated Tactical Mission

Perform the following:

- a. Record complete details of the test range and locations and number of firing points.
- b. Record each detection made by the aircraft and any firings not detected.

6.3.2.3.5 Effects of Atmospheric Conditions

Record the following:

- a. The various atmospheric conditions under which tests were conducted.
- b. Flight procedures used.
- c. Indications of equipment malfunction or loss in performance.

6.3.2.3.6 Durability

For the visual inspection, record the nature and location of the following:

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- 1) Loose components, hardware, and connectors.
- 2) Discolorations.
- 3) Broken or frayed components.

6.3.2.4 Maintenance Evaluation

Record the data required by MTP 7-3-507 and complete the maintenance charts.

6.3.2.4.1 Maintainability

Record the following:

a. For each scheduled or unscheduled maintenance involving minor adjustment.

- 1) Operation performed.
- 2) Personnel, time, tools, etc. required.
- 3) Elapsed time since last performance of the same procedure.
- 4) Difficulty in using instructions provided.

b. For each unscheduled maintenance involving excessive downtime and/or replacement or repair of component, record the data as called for in 6.3.2.4.2b.

6.3.2.4.2 Reliability

Record the following:

a. Total operating time of the system.

b. For unscheduled maintenance procedures involving downtime:

- 1) Failure conditions indication - loss of power, etc.
- 2) Failing component and procedures used to determine it.
- 3) Signs of damage to other components; e.g., burns, etc.
- 4) Repair procedures, personnel, material, tools, and equipment utilized.
- 5) Operating time of failing component, and time to repair.

c. The reliability figure in MTBF and also MTTR.

d. Record the inherent and achieved availability figures in percentage.

6.3.2.4.3 Tools and Test Equipment

Record the following:

- a. All tools and test equipment not specified but required.
- b. Special tools provided but replaceable by those found in the maintenance facility complement.
- c. Recommendations for changes to tools or test equipment.

6.3.2.4.4 Technical Manuscripts and Draft Manuals

Record the following:

- a. Procedures which are inaccurate, incomplete, or not understandable.
- b. Missing lists or procedures for specific maintenance; e.g., calibration missing.

6.3.2.5 Compatibility

Record the data required by MTP 7-3-509 and MTP 6-3-513 and instances of the following:

- a. Physical or electrical characteristics not compatible with aircraft capabilities.
- b. Communication system interferes or is interfered with by other equipment generating, utilizing, or radiating electrical energy.
- c. System not compatible with existing aircraft electronic equipment.

6.3.2.6 Draft Technical Manuals

Record any instances, for all tests, of information which is missing, incorrect, unclear, or not according to format.

6.3.2.7 Safety

Record the data required by MTP 7-3-506 and the following:

- a. Comments regarding unsafe conditions found in the procedures of any test.
- b. For general safety characteristics:
 - 1) Poorly worded or unclear operating instructions.
 - 2) Warning labels - lacking, not conspicuous.
 - 3) Unprotected electrical circuits.
 - 4) Markings for environmental limitation missing.

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- c. Prepare a table to include the following:
 - 1) A list of all safety devices utilized.
 - 2) The type of failure each device is to detect.
 - 3) Indication that the device has successfully operated.
- d. List any missing devices or unsafe conditions.
- e. List any suggested additions to the safety features.

6.3.2.8 Human Factors Evaluation

Record the data required by MTP 7-3-510 and, in addition, complete the checklists prepared for the tasks of the procedures for preparing, operating, maintaining and transporting the system. Rate each task as satisfactory or unsatisfactory from a human factors standpoint. In rating each task consider and record instances of the following:

- a. Instructions.
 - 1) Lacking clarity.
 - 2) Insufficient or excessive detail.
- b. Tools.
 - 1) Proper tools not supplied.
 - 2) Excess of special tools specified.
 - 3) Additional tools recommended.
- c. Mental and Physical Effort.
 - 1) Above average skill or strength required of test personnel.
 - 2) Task is excessively tiring.
- d. Design.
 - 1) Poor location of component.
 - 2) Component not accessible.
 - 3) Visibility hindered.
 - 4) Insufficient variables (controls, adjustments).
- e. Time required for task is excessive and reasons why.
- f. Personnel Requirements.
 - 1) Insufficient number specified.
 - 2) Qualifications in error.

6.3.2.9 Personnel and Training Requirements

Record the following:

- a. The most appropriate skill levels and experience (background) suggested for operator and maintenance personnel.
- b. Any suggested changes to training techniques, literature, etc., to eliminate operator errors or reduce maintenance time.
- c. Each additional training technique utilized after the start of testing and suggestion for additions or deletions to the training program.
- d. The training time, in hours, for maintenance and operating personnel.

6.4 DATA REDUCTION AND PRESENTATION

6.4.1 Environmental Noise Tests

Wxamine all of the test data and establish whether or not the system is overly susceptible to environmental noise; e.g., do the available controls not allow for elimination of most noise, do unexplainable miscounts occur, etc. Of particular importance will be the ability of the system to function reliably during the solo flight procedures of the aircraft on which it is installed.

6.4.2 Fire Detection Tests - Aircraft on Ground

Using the data accumulated, determine how the system response depends on distance of firing, angle of firing, weapon type, mode of firing, etc.

6.4.3 Fire Detection Tests - Aricraft Airborne

Summarize the data contained in the tables by determining the following:

- a. System response as a function of distance and of angle.
- b. Any gross voids in the detection pattern.
- c. Variation of response with weapon, ammunition, firing mode, etc.

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6.4.4 General

a. The remainder of the data will be summarized as appropriate. Photographic records will be positively identified. The total data will be analyzed to determine to what degree the detection system and its maintenance package meet the requirements of QMR's, SDR's, TC's, and detailed military specifications. Record all shortcomings or deficiencies.

b. The data will be further analyzed to determine the extent to which the system under test exceeds the performance characteristics or otherwise provides distinct advantages over existing Army equipment providing for the same requirements. Provide a recommendation as to the suitability of the detection system and its maintenance test package for use by the Army

APPENDIX A

RELIABILITY CALCULATIONS

I. MEAN TIME BETWEEN FAILURES (MTBF):

MEAN TIME BETWEEN FAILURES is the total operating time divided by the total number of chargeable system failures occurring during the total test period.

II. Inherent Availability (A_i).

The probability that a system or equipment when used under stated conditions, without consideration for any scheduled or preventive maintenance, in an ideal support environment (i.e., available tools, parts, manpower, manuals, etc.) shall operate satisfactorily at any given time. A_i excludes ready time, preventive maintenance downtime, supply downtime, and waiting or administrative downtime. It may be expressed as--

$$A_i = \frac{MTBF}{MTBF + MTTR}$$

where

MTBF=Mean-time-between failure; and MTTR=

MEAN TIME TO REPAIR: that portion of the total unscheduled maintenance time which is expended to correct chargeable system failures divided by the total number of chargeable system failures occurring during the total test period.

III. Achieved Availability (A_a).

The probability that a system or equipment when used under stated conditions in an ideal support environment (i.e., available tools, parts, manpower, manuals, etc.) shall operate satisfactorily at any given time. A_a excludes downtime and waiting or administrative downtime. It may be expressed as--

$$A_a = \frac{MTBM}{MTBM + \bar{M}}$$

where

MTBM = Mean-time-between-maintenance; is the total operating time,

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divided by the total preventive (scheduled) and corrective (unscheduled) maintenance actions occurring during the total test period and

\bar{M} = Mean active maintenance downtime resulting from both preventive and corrective maintenance actions.

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